Bulk or Balance: Participation and General Health Outcomes in TBI Patients

Undergraduate Research Thesis

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Abstract

BACKGROUND: Traumatic Brain Injury (TBI) is a chronic health condition with severe physical, social, and cognitive implications. Individuals who have sustained a TBI likely experience deficits in frontal brain executive functioning, which is needed for successful living within the community. This decreased ability to participate and restrictions in life involvement potentially increase one's risk for various health-related problems. OBJECTIVE: This study sought to determine the extent to which the amount or the balance across the domains of participation predicts health outcomes in TBI patients. In the context of the current study, balance is defined as having sufficient equilibrium between the three domains of participation. Data was originally collected through the Ohio Regional TBI Model Systems longitudinal study through participant interviews. It had not been analyzed in this context. METHODS: Participation at one year post-injury was measured over three domains: productivity, social relations, and being out and about in the community, using the Participation Assessment with Recombined Tools – Objective (PART-O). The standard deviation of the three domains was used to determine balance across these areas. The average item score was used to determine overall amount of participation. Health outcomes at two years post-injury were measured using questions regarding current ratings of health and physical health relative to the past year, as well as a questionnaire that assessed depression symptoms (Patient Health Questionnaire, PHQ-9). Multiple and logistic regression were applied to control for covariates that have previously been associated with health outcomes. RESULTS: This study found that greater participation at one year post-TBI is associated with lower likelihood of symptoms of major depressive disorder ($p = 0.027$) and better subjective ratings of current health ($p = .001$) reported at two years post-TBI. Balanced participation was not associated with health outcomes. CONCLUSION: Early intervention with participation in TBI patients may improve depressive symptoms and subjective feelings of health. Further understanding of these relationships will allow for improved treatment and rehabilitation in patients following a brain injury.

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Introduction

Traumatic brain injury (TBI) can be considered a chronic health condition due to the nature and severity of its impacts on various health outcomes including physical, social, and cognitive implications (Corrigan, 2015). A TBI is a temporary or permanent insult to the brain caused by an external force that results in an altered state of consciousness and one or more impairments of brain functioning. In 2013, it was estimated that 2.8 million Americans sustained a TBI that warranted necessary medical attention including emergency department visits, hospitalizations, and deaths (Taylor, Bell, Breiding, & Xu, 2017). However, these numbers do not include individuals who do not seek treatment for a potential TBI. TBI causes a significant amount of direct and indirect costs to healthcare and productivity and can lead to various health problems. All aspects of functioning including basic activities of everyday life are affected by TBI; approximately 43% of hospitalized TBI survivors identified as having a disability one year post-injury in 2003 (Selassie et al., 2008). An estimated 3.17 million Americans were living with a permanent TBI-related disability at the beginning of 2005 (Zaloshnja, Miller, Langlois, & Selassie, 2008).

It is common for many areas of the brain to be injured during a TBI, regardless of the point of impact to the head (Centre for Neuro Skills, 2017; Model Systems Knowledge and Translation Center, 2017). When the brain makes impact with the skull, it causes bruising and tearing of the brain, especially in the brain stem and frontal and temporal lobes. The cortex near the frontal areas of the brain contains dense grey matter which can become bruised (Corrigan, 2015). Individuals with frontal lobe damage often experience problems with executive functioning, which is necessary for living in society and as successful members of the community compared to being in an institutionalized setting. Executive functioning includes

higher cognitive functions that involve behavior and emotion. Some examples are initiation, problem solving, impulse control, concentration, awareness of self, planning/anticipation, organization, mental flexibility, and motor planning. After sustaining a TBI and likely experiencing problems with higher cognitive functioning, it is common for individuals to have difficulties with financial hardship, substance abuse, anxiety, and depression. A study by Corrigan, Whiteneck, and Mellick in 2004 found that a year following their injury, 40% of individuals hospitalized for TBI had at least one unmet need for services including improving memory and problem solving, managing stress and emotional upsets, controlling temper, and improving job skills. Due to these barriers created by their brain injuries, people who have experienced TBI often have difficulty accessing and remaining engaged in services as well as locating and consistently using proper supports (Corrigan, 2015).

These limitations can lead to restrictions in participation, which are common for persons with physical and/or mental disabilities who may experience difficulty functioning in life situations and within the community. From 2001 to 2007, approximately one-third of patients who sustained a TBI were not able to perform everyday activities independently and 57% were classified as moderately to severely disabled (Corrigan et al., 2014). A study by Wise et al. in 2010 concluded that after experiencing a TBI, patients demonstrate less independence in performing activities and less activity overall. Many individuals involved in the study did not return to their preinjury levels of participation and tended to replace sports and activities of social engagement with watching television. Activities such as watching television do not promote societal involvement, which is problematic for individuals who have experienced a brain injury since they are already less active and less likely to be integrated within the community as compared to the general population (Brown, Gordon, & Spielman, 2003; Linden,

Crothers, O'Neill, & Mccann, 2005). As social beings, humans require human interactions and relationships to function within the culture and to remain physically and emotionally sound. A 2000 study by Dijkers, Whiteneck, and El-Jaroudi states, "[S]ocial reflects that humans are social beings, who become human through social intercourse, learn skills in interaction with others, and accomplish all that is needed for living in direct or indirect exchange with others." Thus, after an individual sustains a TBI, their ability to be social is limited; this might impact their subjective feelings of well-being as a human. The Dijkers, Whiteneck, and El-Jaroudi (2000) study reviewed measures of social outcomes and recommended that participation in society be included in disability and rehabilitation research due to its significance on outcomes for persons with disabilities at the same level as impairments and activity limitations. It also confirmed that "[p]eople with disabilities clearly value social outcomes – the extent to which they are active, productive members of society, well integrated in family and community life." It is evident that community participation and integration is an important facet of overall greater well-being and experiencing an injury that limits participation might lead to an overall decrease in physical, mental, and emotional health.

Studies of the impacts of social participation in other countries have suggested that involvement with others and within the community is important for health in all age groups and that increased mortality is associated with low social participation (Lee et al., 2007; Dalgard & Lund, 1998). Participation in community and social activities can provide greater support and motivation for a healthier lifestyle, skills and challenges that promote physical health, and protection against the negative effects linked to social isolation (Lee et al., 2007). Previous studies across the general population have indicated that individual social participation is significantly associated with self-ratings of health and physical activity (Lindström,

Moghaddassi, & Merlo, 2004; Greiner et al., 2004). Most studies examining community and social participation as it affects health outcomes in clinical populations have been fairly recent. In 2007, a study by Campen and Iedema suggested that only weak correlations exist between levels of involvement and subjective well-being in persons with physical disabilities. Since then, community integration has been shown to be negatively correlated with emotional distress in adults with TBI and specific aspects of participation, such as the attendance of religious services, have demonstrated positive effects on rehabilitation from brain injury (Williams, Rapport, Millis, & Hanks, 2014; Philippus et al., 2016). Forslund, Roe, Sigurdardottir, & Andelic (2013) found that higher levels of community integration in TBI patients in Norway predicted better self-reported physical health two years post-brain injury. Levels of depression in TBI patients have been previously associated with participation in that measures of societal participation at one year following TBI are significantly related to depression severity, controlling for all other predictors (Hart et al., 2011). In a longitudinal study, individuals with depression at Year 1 experienced worsened symptoms over the next year with poor social support (Hart et al., 2012). When a person is involved in life situations at home and in the community, their overall health, which includes mental and social well-being as well as physical strength and the absence of disease, is affected (Lee et al., 2007).

Cicerone in 2004 reiterates that "it often seems to be an implicit assumption that increased levels of social participation should be accompanied by greater subjective well-being and satisfaction with functioning among individuals with TBI." However, our study did not assume that *only* the amount of one's participation is what is important; it also included balance between participation domains as a potential predictor of health outcomes. There is not yet a large research base examining specifically balanced measures within the domains of

participation in clinical populations. Work-life balance (WLB) has been defined in the previous literature as the extent to which an individual perceives conflict across multiple life roles (Haar, Russo, Suñe, & Ollier-Malaterre, 2014; Greenhaus & Allen, 2011). These roles can include work, school, family, and time spent socializing, all of which can be measured in the construct of participation. More participation is not necessarily better as it may just mean that the person is busy; it does not allude to any satisfaction gained by participating. The fact that a person participates might be less important than *how* they participate. Negative relationships between work-life interference and physical health outcomes, including decreased physical activity and lesser consumption of healthy foods, have been found in studies involving the general population (Allen & Armstrong, 2006). Wang, Afifi, Cox, and Sareen (2007) found that those who reported high conflict in separate roles had a significantly higher prevalence of mental and/or substance use related disorders than those with lower levels of conflict. WLB was observed to be negatively associated with anxiety and depression across seven cultures in study by Haar, Russo, Suñe, & Ollier-Malaterre (2014). Conflict between work and domestic roles can lead to stress and poor health in both physical and mental states and has been shown to be positively related to self-reported poor physical health (Greenhaus, Allen, & Spector, 2006; Wang, Afifi, Cox, & Sareen, 2007; Frone, 2003). Additionally, flexibility within roles can lead to positive health benefits over time (Casey & Grzywacz, 2008). These findings suggest that "it is not the amount of engagement, but rather the balance among diverse roles, particularly between work and other life roles, that may predict better health and well-being" (Bogner et al., 2011). Studies of patient engagement in various domains of participation could promote greater understanding of how persons with disabilities function amid role conflict and how community integration impacts physical and mental health and contributes to rehabilitation efforts.

Our study seeks to determine whether the amount or the balance across the domains of participation at one year post-TBI is a better indicator of health outcomes measured at two years post-TBI. We predict an association between higher amounts of participation with better health outcomes. We also predict that less variance between domains of participation will be associated with better health outcomes.

Methods

The Traumatic Brain Injury Model Systems (TBIMS) longitudinal study examines various aspects of individuals' lives after experiencing and receiving treatment for a TBI. The TBIMS study includes sixteen Models System Centers and three Model System Longitudinal Follow-up Centers across the nation (Traumatic Brain Injury Model Systems National Data and Statistical Center, 2016). Specific inclusion criteria are used when recruiting participants. Patients must sustain a moderate or severe TBI; be age 16 or older at the time of the injury; present to a TBIMS acute care hospital emergency department within 72 hours following their injury; receive acute care and inpatient rehabilitation through a designated TBIMS hospital; and have the ability to provide informed consent or a family member that agrees to act as a proxy (Traumatic Brain Injury Model Systems National Data and Statistical Center, 2016). This study examined data collected by the Ohio Regional Traumatic Brain Injury Model System. It assessed measures of participation and health outcomes gathered through interviews with participants at follow-up. The data for all variables had already been collected, but it had not yet been analyzed in this context.

After obtaining patient consent, protocol for the TBIMS study requires data collection during the acute-care and rehabilitation periods as well as through follow-up interviews at Year 1, Year 2, Year 5, and each fifth year subsequently following the brain injury. Follow-up

interviews are typically done over phone with exceptions depending on the situation of the participant. Interviews can also be administered in person or through the mail. Ideally, interviews are done with the actual patient, but best-source interviews can be done with close family members or friends who spend time with the individual (Traumatic Brain Injury Model Systems National Data and Statistical Center, 2016). For this study, we looked at three sections of the follow-up questionnaire. Participation measures could be obtained through all interview methods. The depression measure and questions regarding overall current health and physical health in comparison to the previous year had to be obtained from the individual with TBI only.

Participants

The original data collected through the TBIMS longitudinal study contained information for over one thousand participants across hundreds of variables. For the interests of this study, we selected for individuals who had a recorded participation score (PART-O) at the Year 1 follow-up and also had scores for chosen health measures at the Year 2 follow-up. General health was measured using three separate variables: Patient Health Questionnaire 9 (PHQ-9) [N = 232], current self-rated health [N = 157], and self-rated physical health compared to the previous year [N = 157]. The sizes of the samples were determined by when the variables were added to the database; since the health ratings were added later, the number of participants who completed them was smaller.

Independent Variable: Participation

In 2001, the World Health Organization defined participation as "involvement in a life situation" (Traumatic Brain Injury Model System Participation Special Interest Group, 2014). Previous research by Whiteneck et al. in 2011 has shown that "[p]articipation has much in

common with social health, social adjustment, and social or community reintegration, all of which refer to modal or acceptable levels of functioning in social roles and relationships."

The Participation Assessment with Recombined Tools – Objective (PART-O) measure was created to provide a method for quantifying the amount of involvement in life situations (Traumatic Brain Injury Model System Participation Special Interest Group, 2014). The revised measure includes 17 items that cover three domains: Productivity, Social Relations, and Out & About (Bogner et al., 2011). The measure of the amount of activity can be recorded in either hours or days and can vary depending on the activity. Questions #1 – 3 ask how many hours per week individuals engage in productive activities, such as work, school, and active homemaking; questions #4 – 7 ask how many times per week individuals engage in social activities, such as interactions with family and friends, providing emotional support, and using the Internet; question #8 asks how many days per week individuals leave the house; questions #9 – 14 ask how many times per month individuals are out and about in the community, such as going to a restaurant or the movies, shopping, exercising, attending community events and religious services; questions #15 – 17 ask separate questions regarding relationship status, such as having a close friend or intimate partner (Traumatic Brain Injury Model System Participation Special Interest Group, 2014). Results using the PART-O show good psychometric properties and the ability to reliably measure meaningful differences in individuals across varying levels of participation as well as accurately demonstrate expected associations with related constructs (Whiteneck et al., 2011; Bogner et al., 2011). A recent study evaluated the test-retest reliability of several TBI outcome measures including the PART-O and found continued support for the use of this measure as a reliable form of self-report for participation in persons with moderate to severe TBI (Bogner et al., 2017).

Calculated PART-O measures can indicate the level of overall participation and the variability in participation across domains. The PART-O Averaged Total score can range from 0 to 5. It is calculated by finding an individual's average score for each domain and then using these scores to find the Averaged Total Score [(PART-O Averaged Total Score = (Productivity + Social Relations + Out & About)/3]. This measure assumes greater participation is better since current assumptions state that the most ideal level of participation restriction is to have no restriction. This average represents an overall reflection of the amount of an individual's general involvement (Bogner et al., 2011). The PART-O Balanced Total score measures participation as it is distributed across the three domains. It is usually calculated by using the standard deviation of the PART-O domain scores subtracted from the PART-O Averaged Total score. However, for the purpose of this study, we used the standard deviation of the domain scores alone to measure balance across domains. This was to avoid overlap in the calculation of each measure since a measure of amount and a measure of balance were used in the same regression analyses. We defined the balance measure as PART-O SD. Taken together, these amount and balance measures can indicate the level of an individual's overall participation as well as their variability across participation domains. Bogner et al. (2011) recommends that the balance between participation domains may be important to understanding and predicting other outcomes, such as physical and mental health.

Covariates

We used several covariate measures in addition to the independent and dependent variables that we chose for their potential of being associated with health outcomes at Year 2. These are variables that have previously been found to influence outcomes following TBI. Calculated age measured the scale variable of each participant's age. Functional Independence Measures for

cognitive (FIMCOG) and motor (FIMMOT) performance at admission and at Year 1 measured levels of required assistance, with higher scores being associated with greater independence and less needed supervision. FIM at admission indicates initial disability level while FIM at Year 1 indicates disability level that can be influenced by injury severity, rehabilitation, environment, and other factors. We wanted a measure of initial disability as well as a measure indicating impairment at the time of participation. Marital status at Year 1 was coded dichotomously as either married or not married. Sex was classified as either male or female, with the vast majority of the clinical population under study identifying as male. Race was coded dichotomously as either minority or not minority. Alcohol and drug use at Year 1 was coded dichotomously for the presence of excessive or problematic alcohol and/or drug use. Level of education was coded dichotomously for less than high school or high school and above.

Dependent Variables: Health Outcomes

Health outcomes at Year 2 were measured using three separate dependent variables that assessed current overall health, physical health in comparison to the previous year, and symptoms for major depression (MD).

The overall health and physical health questions came from a section of the follow-up questionnaire that assessed health using four separate questions to be asked to the person with TBI only. Two of these questions have failed to show good test-retest reliability in a recent study by Bogner et al. (2017), so they were not included in the analyses. The overall current health question asks, “In general, would you say your health is…,” and answer scores can range from “1” (Excellent) to “5” (Poor). The physical health questions asks, “Compared to one year ago, how would you rate your physical health in general now?” and answer scores can range from “1” (Much Better) to “5” (Much Worse). Lower scores indicate better self-ratings of health for these

variables. It is likely that most participants interpreted both questions with physical health in mind, so the primary difference between the two questions is whether they perceived a change in health from the previous year.

The PHQ-9 is a 9-item depression module that is used to assess for the presence of MD (Kroenke, Spitzer, & Williams, 2001). Studies of the PHQ-9 measure have found strong evidence for its reliability and validity as a brief measure of depression severity in persons with TBI (Fann et al., 2005). Each item on the questionnaire can be evaluated as "0" (not at all) to "3" (nearly every day). Therefore, total scores can range from 0 to 27. We coded the PHQ-9 scores into binary levels for participants who met standards for MD versus those who did not. To be classified as having symptoms of MD in this study, individuals must present with five or more of the 9 depressive symptom criteria at least "several days" over the past 2 weeks. One of the symptoms must be depressed mood or anhedonia (Fann et al., 2005). Scores meeting these criteria on the PHQ-9 measure were coded 1 = 'YES'; all others as 0 = 'NO' for existence of required MD symptoms.

Data Analysis

Cases that did not contain any follow-up period data were deleted from analysis. This resulted in 1,096 cases with completed entries for both Year 1 and Year 2 follow-up interviews. Data that was collected but had a label such as refused, unknown, lost, or other was coded as missing across all variables, including covariates. Table 1 shows how we obtained the number of individual cases included in each analysis. All statistical analyses were performed using IBM SPSS Statistics for Windows (version 24.0). Basic frequency tests were initially run for all variables to assess for normal distribution and to check for concerning trends in the data. A correlation matrix between all four FIM items was tested to check for the potential for

collinearity. Multiple linear and binary logistic regression were applied to test the hypothesis and to control for covariates. We ran linear regression models for each of the questions assessing overall ratings of current health and physical health. Each model included all covariate measures. Since the PHQ-9 dependent variable was coded dichotomously, a binary logistic regression model was used. In this analysis, population proportions are determined through the mean of outcomes with either '0' (no) and '1' (yes). All covariate measures except for the FIM items collected at Year 1 were included in the first step of the analysis. FIMMOT and FIMCOG at Year 1 were then added in during the second step to further evaluate for any issues with collinearity.

Table 1. Cases Included in Analyses

Cases with completed entries for Year 1 and Year 2 1096	Cases with valid PHQ-9 score at Year 2 (0 – 27)	Logistic Regression with PHQ-9: Cases with no missing values for any variable used
	308	232
	Cases with valid Self-rated Health Questions at Year 2	Linear Regression with Self-rated Health Questions: Cases with no missing values for any variable used
	170	157

Results

Participant Demographics

For the group of 308 participants with a valid PHQ-9 score at Year 2, the mean age was 39.3 (SD = 15.81) and 74.7% of participants were male. It is typical for males to be the dominant gender in TBI populations; our sample contained a slightly greater percentage than previous population characteristics recorded from 2001 to 2007 (Corrigan et al., 2014). Most individuals (85.2%) did not identify as being part of a minority group. The sample also tended towards a higher education level, with 84.1% having a high school diploma or greater. A larger percentage

of participants identified as not married at their Year 1 follow-up (69.5%). Many did not indicate problematic use of drugs or alcohol (76.7%). Of the 308 individuals, 214 (69.5%) did not meet the designated criteria for qualification of MD symptoms.

For the group of 170 participants with valid answers to the self-rated health questions at Year 2, the mean age was 39.43 (SD =16.51) and 72.9% of participants were male. Again, most individuals (88.2%) did not identify as being part of a minority group. An overwhelming amount of participants (88.2%) had an education level of high school or greater. This sample was similar in marriage with 69.4% of participants identifying as not married at one year post-brain injury. Many did not indicate problematic use of drugs or alcohol (75.8%).The mean for the question assessing current ratings of health was 2.88 (SD = 1.014) and the question assessing physical health relative to the previous year had a mean of 2.18 (SD = 1.058).

Binary Logistic Regression with PHQ-9

This study ran a two-step binary logistic regression analysis to examine the predictive relationship between levels of participation and general health as measured by the PHQ-9 dichotomous score. The first step included the PART-O Averaged Total Score as the measure of participation amount, the standard deviation of the PART-O domains scores (PART-O SD) as the measure of participation balance, and all covariates except FIMCOG and FIMMOT at Year 1. The second step added FIMCOG and FIMMOT at Year 1. The additional FIM measures did not alter the analysis results in the second step and tests for collinearity did not show significant relationships between the four FIM measures. Further reporting of the results will focus on the second step of the logistic regression analysis which utilized a predictive model that included all covariate measures. Table 2 shows the logistic coefficient values (*B*) as well as the standard error for each predictor in the model. Our research question focused on the relationships between the

measures of participation and depressive symptoms. The analysis showed that the PART-O Averaged Total score, which accounts for the amount of participation at Year 1, made a significant contribution to prediction (*p = .027*). PART-O SD scores did not show significant predictive value for MD symptoms. A test of the whole model against a constant-only model was statistically significant, indicating that the predictors were better than the constant-only model at distinguishing between patients with qualifications for MD and patients without qualifications for MD (*chi square = 40.346, p < .001 with df = 12*). Nagelkerke's R^2 of .232 indicates a relatively weak relationship between the predictors and the prediction of the dependent variable. Overall prediction success was 76.3% (93.5% for patients without MD qualifications and 29.0% for patients with MD qualifications). Additionally, FIMCOG was a significant predictor at admission (*p = .004*) and also at Year 1 (*p = .012*). It is interesting to note that the coefficient values for FIMCOG at admission and at Year 1 were opposite in direction. All other predictors were not significant.

Table 2. Logistic Regression – DV: PHQ-9 [Dichotomous] (Year 2)

Variables in the Equation	**Step 2**	
	B	S.E.
Minority	-.459	.474
Education (Year 1)	.599	.447
Marriage (Year 1)	.215	.432
Sex	.614	.376
Age	-.016	.012
Alcohol & Drug Use (Year 1)	-.526	.440
PART-O Averaged Total (Year 1)	**-.762***	.345
PART-O SD (Year 1)	-.156	.438

FIM Motor (Admission)	.005	.011
FIM Cognitive (Admission)	**.090****	.031
FIM Motor (Year 1)	-.033	.035
FIM Cognitive (Year 1)	**-.161***	.064

***Significance at α = 0.05; **Significance at α = 0.01**

Multiple Linear Regressions with Health Questions

The study also ran two multiple linear regression analyses to examine the predictive relationship between levels of participation and health as measured by questions rating current health and physical health relative to the previous year. All covariate measures were contained in each regression analysis. Table 3 shows the standardized coefficient values (*Beta*) for each individual predictor in the models. The only result directly related to our research question was that the PART-O Averaged Total significantly contributed to the model for predicting participant's current self-ratings of health ($p = .001$). PART-O SD scores were not significantly related with either dependent variable. When the dependent variable was current self-ratings of health, 21.2% of the variation in participant scores could be explained by the model (*R Square = .212*). Overall, this regression model statistically significantly predicts the outcome of the overall self-ratings of general health ($F(12) = 3.231$, $p < .001$). When the dependent variable was ratings of physical health relative to the previous year, 16.7% of the variation in participant scores could be explained by the model (*R Square = .167*). Overall, this regression model also statistically significantly predicts the outcome of the self-ratings of physical health compared to the previous year ($F(12) = 2.405$, $p = .007$). Both of these models demonstrate relatively low predictive value. FIMMOT at admission ($p < .001$) and FIMCOG at Year 1 ($p = .046$) were the only individual predictors that contributed significantly to the physical health model. PART-O

Averaged Total scores and PART-O SD scores were not associated with self-ratings of physical health compared to the previous year.

Table 3. Linear Regression – Self-rated Health Questions (Year 2)

Variables in the Equation	**Standardized Coefficients (Beta)** **DV: Current Health**	**Standardized Coefficients (Beta)** **DV: Physical Health Comparison**
Minority	-.100	-.077
Education (Year 1)	.088	.132
Marriage (Year 1)	.022	.070
Sex	.028	-.061
Age	.116	-.063
Alcohol & Drug Use (Year 1)	-.015	-.069
PART-O Averaged Total (Year 1)	**-.328****	-.003
PART-O SD (Year 1)	.055	.044
FIM Motor (Admission)	.020	**.336****
FIM Cognitive (Admission)	.063	.018
FIM Motor (Year 1)	-.058	.001
FIM Cognitive (Year 1)	-.154	**-.172***

***Significance at α = 0.05; **Significance at α = 0.01**

Discussion

The major result found in this study was that greater participation at one year post-TBI is associated with a) lower likelihood of symptoms of major depression and b) better subjective ratings of health reported at two years post-TBI. Balanced participation was not associated with health outcomes. Participants' subjective rating of their physical health at Year 2 compared to the year prior was not found to be related to participation at Year 1.

An individual with a history of TBI may experience reduced executive functioning, precluding full societal and community involvement. Our study suggests that the amount of participation that TBI patients experience at one year following injury might predict health outcomes the following year, as measured by depressive symptoms and ratings of current health. Our study results are consistent with literature that relates community and social participation to lesser emotional distress and greater subjective functioning (Williams, Rapport, Millis, & Hanks, 2014). Consistent with the findings from the Forslund, Roe, Sigurdardottir, & Andelic (2013) study in Norway, we found a significant association between higher levels of community integration and better self-reported current health. Our results also showed similar findings to the study by Hart et al. (2011) which found a significant relationship between depression severity, measured by the PHQ-9, and levels of societal participation, measured using PART-O, at one year post-TBI. The primary difference between the latter study and the current study is the temporal relationship between participation and depression symptoms. Our findings failed to be consistent with any of the WLB literature that suggests more positive health benefits associated with greater WLB within the general population. Previous literature has examined perceived WLB, while this study used an objective measure of balance. It is possible that balance within the domains of participation only matters to the extent that it is recognized by the individual. Individuals' subjective feelings towards their WLB might have a stronger relationship with health as compared to objective measures of balance.

While not the focus of the current study, we found significant but contradicting relationships between FIMCOG at admission and FIMCOG at Year 1 with depressive symptoms. We would assume a consistent relationship between the variables across follow-ups, where higher FIM scores predict lower probability for depressive symptoms. However, it is possible

that patients with higher cognitive functioning at admission are more likely to perceive health problems due to their greater cognitive ability. This would potentially account for the finding of a higher FIMCOG score at admission predicting greater probability for depressive symptoms.

Study Limitations

Our study examined a limited population of TBI patients who were enrolled in the Ohio Regional Traumatic Brain Injury Model System. It is unclear how these results would generalize to populations in other areas of the United States or outside of the country that might have greater opportunities for participation or differing cultural views surrounding community and social integration. We must also be careful when looking at population demographics since the majority of our samples identified as not part of a minority group. Culture and race might intersect to affect individuals' chances for community participation. Due to the nature of our dependent measures, we could not include patients who were unable or unwilling to do the interview themselves.

The PART-O measure used for assessing participation might also be seen as a potential limitation. It is difficult to capture equivalent amounts of participation between domains; working a full-time job and having a close friend can receive the same score, yet it is not obvious that these are readily equivalent constructs. Similarly, it is difficult to compare items based off of different frequencies (weekly, monthly, etc.) (Bogner et al., 2011). In order to avoid overlap in the amount and balance measures, we had to modify the calculation of the PART-O Balanced Total score which might impact the effectiveness of the balanced participation measure. Questionnaires are voluntary, which could also lead to bias in the study if a common factor exists between those individuals who completed the included measures.

The definition of WLB includes individuals' perception of conflict between various life roles. Further limitations to this study are that we did not measure 'perception' of participation balance, but instead used a direct measure of balance, which might have different implications for health. How a person participates might only matter to the degree that they feel satisfied with their individual levels of participation between domains. We suggest that further research assesses WLB specifically to better capture the subjective conflict that patients might feel within life roles. Further studies could add a question involving patients' perception of participation conflict within their lives.

In further studies, we might also choose different constructs to measure health outcomes. Various measures have been used in the previous literature to assess the constructs of participation and health. Since this study used data from a larger, established database, we only had access to the variables being measured as part of the larger TBIMS study. In the future, we could use more comprehensive measures of health that involve emotional and social aspects as well as measure direct physical attributes of health in addition to self-reports. PHQ-9 scores could be separated into specific categories for mild, moderate, moderately severe, and severe depression. Additional suggestions are to separate participation into each of the three domains and test the predictive power of each domain. We might also include measures of health at Year 1 as a predictor for health outcomes at Year 2. Additional research can further explore the numerous ways of measuring the subjective constructs of participation and health.

Conclusion

Future studies should continue to examine the relationships between participation and health in clinical populations. Prediction across time is one of the first steps in determining causality, and potential research might benefit from these findings when examining more

detailed connections linking community and social integration with health outcomes. TBI presents a highly complex health condition that is affected by multiple variables; there is still much work to be done in determining the greatest outcomes for individuals with brain injury. Further understanding of the predictive relationships between participation and health outcomes will allow for improved treatment and rehabilitation suggestions in patients following a brain injury.

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